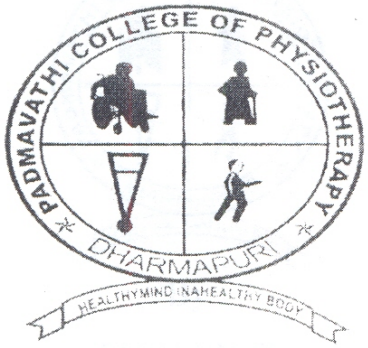
A STUDY TO EVALUATE THE EFFECT OF MIRROR THERAPY ON UPPER EXTREMITY MOTOR FUNCTIONS IN STROKE PATIENTS



By

(Reg. No . 27101811)

PADMAVATH COLLEGE OF PHYSIOTHERAPY

PERIYANAHALLI

DHARMAPURI

A STUDY TO EVALUATE THE EFFECT OF MIRROR THERAPY ON UPPER EXTREMITY MOTOR FUNCTIONS IN STROKE PATIENTS

By

(Reg. No . 27101811)

Under the guidance of

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Assistant Professor,

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Submitted in Partial fulfillment of the requirements for the

Degree of **Master of Physiotherapy**

From

The Tamilnadu Dr. M.G.R. Medical University,

Chennai

PADMAVATH COLLEGE OF PHYSIOTHERAPY

PERIYANAHALLI

DHARMAPURI

CERTIFICATE

This is to certify that the project entitled **"A STUDY TO EVALUATE THE EFFECT OF MIRROR THERAPY ON UPPER EXTREMITY MOTOR FUNCTIONS IN STROKE PATIENTS"**

Submitted by the candidate

(Reg. No . 27101811)

is a bonafide work done in partial fulfillment of the requirements for the Degree of **Master of Physiotherapy** from

The Tamilnadu Dr. M.G.R. Medical University,

Chennai

Guide **Principal**

Viva-voce Examination held on _____

Internal Examiner **External Examiner**

DECLARATION

I hereby declare and present my dissertation entitled entitled **"A STUDY TO EVALUATE THE EFFECT OF MIRROR THERAPY ON UPPER EXTREMITY MOTOR FUNCTIONS IN STROKE PATIENTS"** the outcome of the original research work undertaken and carried out be me , under the guidance of **Mr. G. ELAVARASAN, M.P.T. , MIAP.,** Assistant Professor, Padmavathi College of Physiotherapy, Periyanahalli, Dharmapuri , Tamilnadu.

I also declare that the material of this dissertation had not formed in any basis for the award of any other Degree previously from the Tamilnadu Dr. M.G.R. Medical University, Chennai.

(MOHAMMED SHANAVAS. J)

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(MOHAMMED SHANAVAS. J)

DEDICATED TO MY BELOVED

PARENTS , STAFFS

AND

LOVABLE FRIENDS

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INTRODUCTION

Stroke is the common neurological disease that leads to mortality, morbidity and disability in the adult population. It is the leading cause of severe long term disability in adults. WHO defined stroke as “Rapidly developing clinical signs of focal (or global) disturbance of cerebral function; lasting more than 24 hours or leading to death, with no apparent cause other than vascular origin”.

Worldwide, approximately 20 million people suffer from stroke each year; of them, only 15 million survive. Of those who survive, 5 million will be disabled by their stroke.

Prevalence of stroke in India in 2001 was estimated as 203 per 100000 populations above 20 years amounting to a total of about 1 million cases. The male to female ratio was 1.7:1. Around 12% of all strokes occurred in population below 40 years. 1.2% of total deaths in the country were due to stroke.

Persons with low socioeconomic status have considerable excess rates of mortality and morbidity from ischemic stroke. The major risk

factors for stroke in north Indian young population are hypertension, hypercholesterolemia, hypertriglyceridemia and smoking. Cardio-embolic stroke and atherosclerotic occlusive disease are the most common cause of ischemic stroke.

Stroke is due to upper motor neuron lesion and is characterized by the motor paralysis or paresis, perceptual problems, altered balance, cranial nerve problems, reflex sympathetic dystrophy, shoulder subluxation, gait problems and spasticity.

After the initial flaccid stage immediately following the CVA, reflexes, tone and voluntary movements gradually return over months. Reflexes become hyperactive. Pyramidal tract signs emerge on the hemiplegic side and clonus in both the upper and lower extremities can be present. As voluntary control and strength recover, reflexes tend to become less hyperactive and tone may decrease. This recovery process however, may become arrested at any point, leaving residual weakness, increased tone and hyperreflexia..

Six months after stroke, about 65 percent of patients cannot incorporate the affected hand into their usual activities. Only 25 percent of patients return to the level of everyday participation and physical

functioning of community-matched persons who have not had a stroke. Significant benefit is most often achieved among patients with moderate levels of disability as measured on functional scales, but not among those with the greatest disability.

Traditional rehabilitation programs for improving functional use of the arm, commonly used are compensatory strategies, splinting, task oriented practice strategies, constraint induced movement therapy, electro-myography (EMG) biofeedback, acupuncture, strengthening exercises; and various approaches like neuro-developmental therapy (NDT), proprioceptive neuro-muscular facilitation (PNF), Rood's approach, Brunnstrom approach, Vojta approach. There are now multiple approaches, many relating to brain plasticity, including: (a) Use of a body part enhances its function, for example, by constraint-induced movement therapy, neuromuscular electrical stimulation (NMES), Robot aided movement therapy and virtual reality. (b) The ipsilateral hemisphere can contribute to motor control; bilateral, symmetrical arm movement training may help on this basis. (c) Sensory stimulation enhances plasticity. It can be given through transcutaneous electrical stimulation or acupuncture. (d) Reduction of inhibition enhances plasticity. This has been demonstrated to be useful for rehabilitation utilizing transient deafferentation. (e) Many pharmacological agents can induce plasticity.

Mirror therapy is relatively new therapeutic intervention for stroke patients. It is a simple, inexpensive and, most importantly, patient-directed treatment that may improve upper-extremity function. It involves performing movements of unimpaired limb while watching its mirror reflection superimposed over the (unseen) impaired limb (motor imagery). It creates a visual illusion of enhanced movement capability of the impaired limb.

Ramachandran and Rogers-Ramachandran were the first to introduce the use of these visual illusions created by a mirror for treatment of phantom limb pain. By superimposing the intact arm on the phantom limb using a mirror reflection, patients reported the sensation that they could move and relax the often-cramped phantom limb and experienced pain relief. Since this initial report, successful use of mirror therapy has been reported in patients with other pain syndromes, such as complex regional pain syndrome, and in sensory re-education of severe hyperesthesia after hand injuries.

Studies, although not sufficiently controlled, have suggested that mirror therapy may be effective in stroke patients. Jennifer A. Steven et al. have applied mirror therapy for wrist movements, reaching, and object manipulating tasks on 2 patients with embolic stroke and have suggested

that mirror therapy is a cognitive strategy for functional recovery from hemiparesis. A study on 9 patients with stroke reported that mirror therapy may be beneficial for at least some patients with hemiparesis following stroke and provided impetus to do larger trials of mirror therapy. A randomized controlled trial done by Serap Sutbeyaz et al. suggested that mirror therapy combined with a conventional stroke rehabilitation programme enhances lower extremity motor recovery and motor functioning in subacute stroke patients.

Many mechanisms have been proposed for effect of mirror therapy in motor recovery in stroke patients. Lewin Altschuler et al. found that the mirror provides proper visual input and substitutes for the decreased or absent proprioceptive input. Similarly Serap Sutbeyaz et al. reported that congruent visual feedback and motor imagery as provided by the mirror, would help to restore the integrity of cortical processing and thereby restore the functions.

Studies have been done to know the effect of mirror imagination on brain activation. M.I. Gary et al. suggested that mirror viewing of phasic, unilateral hand movement enhances facilitation of ipsilateral primary motor cortex (M1). This effect did not differ between the dominant and non dominant hand. Buccino et al. reported that motor imitation is a

complex cognitive function that incorporates several stages, including motor observation, motor imagery and motor execution. Motor imitation increases the excitability of corticospinal pathway and represent one type of behavior intervention that can affect neural circuit recognization, employing both direct (restoration of damaged neural circuit) and indirect (adjacent or related neural circuits perform the function) mechanisms. Observation of actions done by other humans activates a complex network formed by rostral part of inferior parietal lobule, lower part of precentral gyrus, occipital, temporal, parietal visual area and posterior part of the inferior frontal gyrus. These regions form the core of the human mirror – neuron system.

Many theories have been proposed to explain the mechanisms by which mental practice acts to increase performance in motor learning. Sackett proposed the symbolic learning theory, which states that mental practice facilitates motor performance by allowing subjects to rehearse the cognitive components of a task. This theory implies that movements are symbolically coded in the CNS, making them easier to execute. The psycho-neuromuscular theory proposes that micro nerve impulses are propagated to target muscles when a subject engages in the mental practice of a movement, hence facilitating future performance by priming specific “mental nodes” or “patterns of movement” necessary to execute a

motor task. An another theory about the effects of mental practice in motor learning comes from Paivio who suggested that mental practice enhances performance by acting on both the motivational and cognitive components of an activity at either general (e.g., the degree of physiologic arousal of an individual) or specific levels (e.g., the actual practice of a motor task using motor imagery).

Thus, studies have shown that mirror therapy is effective for functional recovery of upper extremity after stroke but they are undersized and are not sufficiently controlled. A randomized controlled trial has been shown that mirror therapy improves lower limb functions in subacute stroke. No study has been done to evaluate the effect of mirror therapy on upper extremity motor functions in stroke patients.

Keeping all above in view, purpose of this study is to find out the effect of mirror therapy on upper extremity motor functions in stroke patients.

AIM AND OBJECTIVE OF THE STUDY

To evaluate the effect of Mirror therapy on upper extremity motor functions in stroke patients

HYPOTHESIS

Experimental hypothesis:

- Mirror therapy will enhance upper extremity motor functions in stroke patients

Null Hypothesis:

- Mirror therapy will not enhance upper extremity motor functions in stroke patients

REVIEW OF LITERATURE

G.L. Moseley et al. (2008) evaluated, in their topical review, the current state of the evidence that mirror therapy reduces pain and summarized relevant finding concerning the other effects on the human brain of using mirrors and suggested that mirrors might have utility in pain management and rehabilitation via multisensory interactions.

D. Goel et al. (2008) did a literature review in order to facilitate integration of mirror therapy in physical therapy practice and suggested that the encouraging effect of mirror therapy improves the functional outcome after stroke by facilitating plastic re-organization of the cortex in brain, in response to visual feedback and concluded that mirror therapy may provide a valuable tool to access the motor network and improve outcome after stroke.

C. Brenda et al. (2007) did a randomized, sham controlled trial of mirror therapy versus imagery therapy involving 22 patients with phantom limb pain after the amputation of a leg or foot and concluded that mirror therapy may be helpful in alleviating phantom pain in an amputed lower limb and suggested that pain relief may be due to

activation of mirror neurons in the contralateral hemisphere or reduction of the activity of systems that perceive protopathic pain.

R. Dickstein et al. (2007) synthesized the relevant literature about motor imagery in order to facilitate its integration into physical therapy practice and found that internal (kinesthetic) or external (visual) imagery can be affected by person's imagery ability, task familiarity, working memory or motivation. They have suggested a potential efficiency of mental practice relative to physical practice and it can be used as a complement to physical practice.

S. Sutbeyaz et al. (2007) did a randomized controlled trial to know the effect of mirror therapy in lower extremity of 40 subjects with subacute stroke and concluded that mirror therapy combined with conventional rehabilitation programme enhances lower extremity motor recovery and motor functioning after stroke, but there was no effect on walking ability or spasticity.

K. Funase et al. (2007) examined if direct (without a mirror) and indirect (with a mirror) observation of self movements in 12 healthy subjects induced changes in motor evoked potential (MEP) evoked by Transcutaneous Magnetic Stimulation (TMS) and concluded that

although the mirror neuron system can be activated by observing self movement in a manner similar to that achieved by observing movement of another person, there were no detectable effects on corticospinal excitability which were specific to movements observed with a mirror.

G. Buccino et al. (2007) reviewed the experimental evidence on the role of the mirror neuron system in action understanding, imitation and motor imagery of actions and discussed that systematic activation of the observation-execution matching, ‘‘mirror’’ system of the premotor and parietal cortices can be used to affect functional changes in hand motor function in patients with ischemic stroke. They further postulated that functional outcome of patients with hand motor dysfunction can be influenced by tasks involving observation-execution matching and degree of recovery will depend on changes to ventral and dorsal premotor cortex and pars opercularis ipsilateral to cerebral infarction.

J. J. Summers et al. (2006) did a study to know the effect of bilateral and unilateral movement training on upper limb functions in 12 chronic stroke patients and concluded that a short term bilateral training intervention is effective in facilitating upper limb motor function in chronic stroke patients and mechanism for recovery may be the increased

excitability in homologous motor pathway in the impaired limb by crossed facilitatory drive from the intact hemisphere.

N. Sharma et al. (2006) reviewed the motor imagery training literature focusing on upper limb recovery and functional imaging in healthy subjects and in patients with stroke. They have suggested encouraging effect of motor imagery training on motor recovery after stroke and concluded that provided appropriate methodology is implemental, motor imagery may provide a valuable tool to access the motor network and improve outcome after stroke.

T. J. Kimberley et al. (2006) examined the cortical process associated with imagery of movement of wrist in 10 severe hemiparetic patients using functional magnetic resonance imaging (fMRI) and compared the results with normal individuals.

Following which they found that subjects with stroke displayed primarily ipsilateral activation during imagination of wrist tracking movements with hemiparetic side in contrast to healthy subjects which displayed primarily contralateral activation and concluded that imagery can be used as an adjunct to traditional rehabilitation, as a result from recovered stroke motor control. They have also supported the finding for

imagery training even in subjects with poor imagery ability, as they too may be able to activate functionally relevant areas and benefit from the mental practice.

V. M. Pomeroy et al. (2005) conducted a systemic review of published neuroimaging with 9 papers and demonstrated that there is yet insufficient direct evidence for OTI which might produce activity in the movement execution system including the motor neurons and paretic muscles. Study has provided following suggestions: (1) Studies in normal subjects are needed to determine the activation of different brain sites in response to observation with intent to imitate. (2) Studies are needed in stroke subjects to determine how activation is affected after damage to different brain areas.

G. L. Moseley (2004) examined the effectiveness of graded motor imagery i.e. mirror therapy on 26 patients with long standing complex regional pain syndrome(CRPS) and concluded that motor imagery program, initially not involving limb movement is effective for CRPS type-1. The mechanism of effect, although not clear, may involve sequential activation of cortical pre motor and motor network or sustained and focused attention to the affected limb, or both.

J. A. Stevens et al. (2003) did a case study on 2 patients to examine the effect of motor imagery training in the rehabilitation of hemiparesis and concluded that motor imagery can be used as a cognitive strategy for functional recovery from hemiparesis.

L. Koski et al. (2002) did a study to examine the modulation of motor and premotor activity by fMRI during imitation of target directed actions and found that visible goals modulate human behavior and the motor system during action observation and imitation. A system critically involved during imitation and action observation of target directed actions seems to be located in Brodmann's area 44, an area essential for action understanding and social communication.

J. H. Van der Lee et al. (2001) did a study on 20 subjects with stroke to determine the intra and inter-rater reliability of Action Research Arm Test (ARAT) and confirmed the high intra and inter-rater reliability of ARAT (for intra-rater reliability- ICC=0.997; for inter-rater reliability- ICC=0.989).

P. L. Jackson et al. (2001) discussed the rational for investigating mental practice as a mean of promoting motor recovery in patients with a neurological disorder. They have emphasized the key role of motor

imagery as an essential process of mental practice and stimulated additional research on this type of training in rehabilitation of patients with motor impairment of cerebral origin.

E.L. Altschuler et al. (1999) did a research on 9 patients to evaluate the effect of mirror therapy on upper limb movement ability in patients with hemiparesis following stroke and concluded that mirror therapy is beneficial for at least some patients and given impetus to do larger trials of mirror therapy.

C. L. Hsieh et al. (1998) did a research to verify the inter-rater reliability and validity of ARAT in stroke patients. They found that intra-class correlation coefficient (ICC) for the total score was 0.98 indicating very high inter-rater reliability and the score of the ARAT was closely correlated with that of the upper extremity part of the motor assessment scale, the arm sub-score of the motricity index and the upper extremity movements of the modified motor assessment chart (Pearson r = 0.96, 0.87 and 0.94, respectively) and concluded that consistent and valid information can be obtained from ARAT.

J. Sanford et al. (1993) did a study to establish the inter-rater reliability of assessment made with Fugl-Meyer evaluation of physical

performance in a rehabilitation setting and found that Fugl-Meyer assessment is a moderately reliable (r=0.96) measure for assessing impairment in stroke patients.

METHODOLOGY

Sampling: Purposive sampling

Study design: Experimental study

Sample collection:

22 patients were selected from OPD of Srinivas College of Physiotherapy, Wenlock Hospital, OPD of Vikas College of physiotherapy, Safi Aurvedic Clinic, Mangalore.

Method of collection of data:

22 subjects were selected who fulfilled the inclusion and exclusion criteria. The purpose and procedure of the study were explained to all subjects for maximum cooperation and written consent was taken from them. Detailed assessment was taken for each patient.

Inclusion Criteria:

- Age : 40-60 years
- Brunnstrom stage of motor recovery for upper extremity: 1-3
- Time since stroke: 2months - 1year
- Gender: Both male and female

Exclusion Criteria:

- Severe cognitive disorders that would interfere with study purpose (MMSE < 23/30)
- Bilateral hemiplegia
- Medically unstable patients
- Patients with visual impairments

Materials used:

1. Mirror
2. Tools for Action Research Arm Test:
    a) Wooden blocks: (4 blocks):
        i. 10cm × 10cm × 10cm
        ii. 7.5cm × 7.5cm ×7.5cm
        iii. 5cm × 5cm × 5cm
        iv. 2.5cm × 2.5cm × 2.5cm
    b) Cricket ball
    c) Sharpening stone
    d) Water glasses (2 pieces)
    e) Alloy tube (2.5cm, 1cm diameter)
    f) Washer & bolt
    g) Ball bearing (6mm)
    h) Marble

3. Reflex hammer

4. A pencil and worksheets

Outcome Measure:

- **Action research arm test: (ARAT)**
  - It is reliable and valid measure to assess upper limb functions in stroke patients.[39] It has 4 components: grasp, grip, pinch and gross movement.
- Upper extremity subscale of Fugl-Meyer motor assessment scale: (FGMR)
  - It is 3 point ordinal scale to measure impairments of volitional movements. It has good validity and high reliability.[41] It is having 4 components: shoulder/elbow/wrist, wrist, hand and co-ordination/speed.

The subjects were randomly allocated to either Mirror therapy group (Group A) or control group (Group B) by using sealed envelopes. ARAT and Fugl-Meyer assessment for upper extremity (FGMR) were performed before and after intervention of 4 weeks in both groups.

1. **Group - A: Mirror therapy group (11 subjects):**

   Patients were given Mirror therapy and conventional therapy.

   Mirror therapy:

   The patient was made to sit on chair in front of a table, on which a mirror was placed. The patient was asked to place both unaffected and affected hands on each side of the mirror. Reflected side of mirror was placed towards the unaffected side of the patient. The patient was then asked to perform following exercises with unaffected upper limb and with affected limb (as much as possible):

   1. Active wrist extension for 5 minutes (fig.:4.2)
   2. Supination - pronation for 5 minutes (fig.:4.3)
   3. Fingers flexion - extension for 5 minutes (fig.:4.4) and
   4. Moving different objects (pen, wooden blocks etc.) from one place to another for 5 minutes (fig.:4.5)

   While doing above exercises, the patient was asked to observe the reflection of unaffected extremity in mirror (which looks like the affected extremity) and to imagine that his/her affected extremity is moving normally (motor imagery).

   The Mirror therapy was lasted for 20 min/day, 5 days/week for 4 weeks.

- **Conventional therapy:**

Conventional therapy was patient specific. It included NDT approach, Motor relearning program, Brunnstrom approach, Rood approach, splinting, task oriented approach, strengthening, etc.

2. Group – B: Control group (11 Subjects):

The patient was asked to perform same exercises (wrist flexion-extension, supination-pronation, fingers flexion-extension and moving different objects from one place to another) as in Mirror therapy group but the mirror was placed in opposite direction so that the patient observed the reflection of the affected extremity (placebo Mirror therapy).

Conventional therapy was given as in the Mirror therapy group to all patients.

Figure 4.1: Tools of data collection

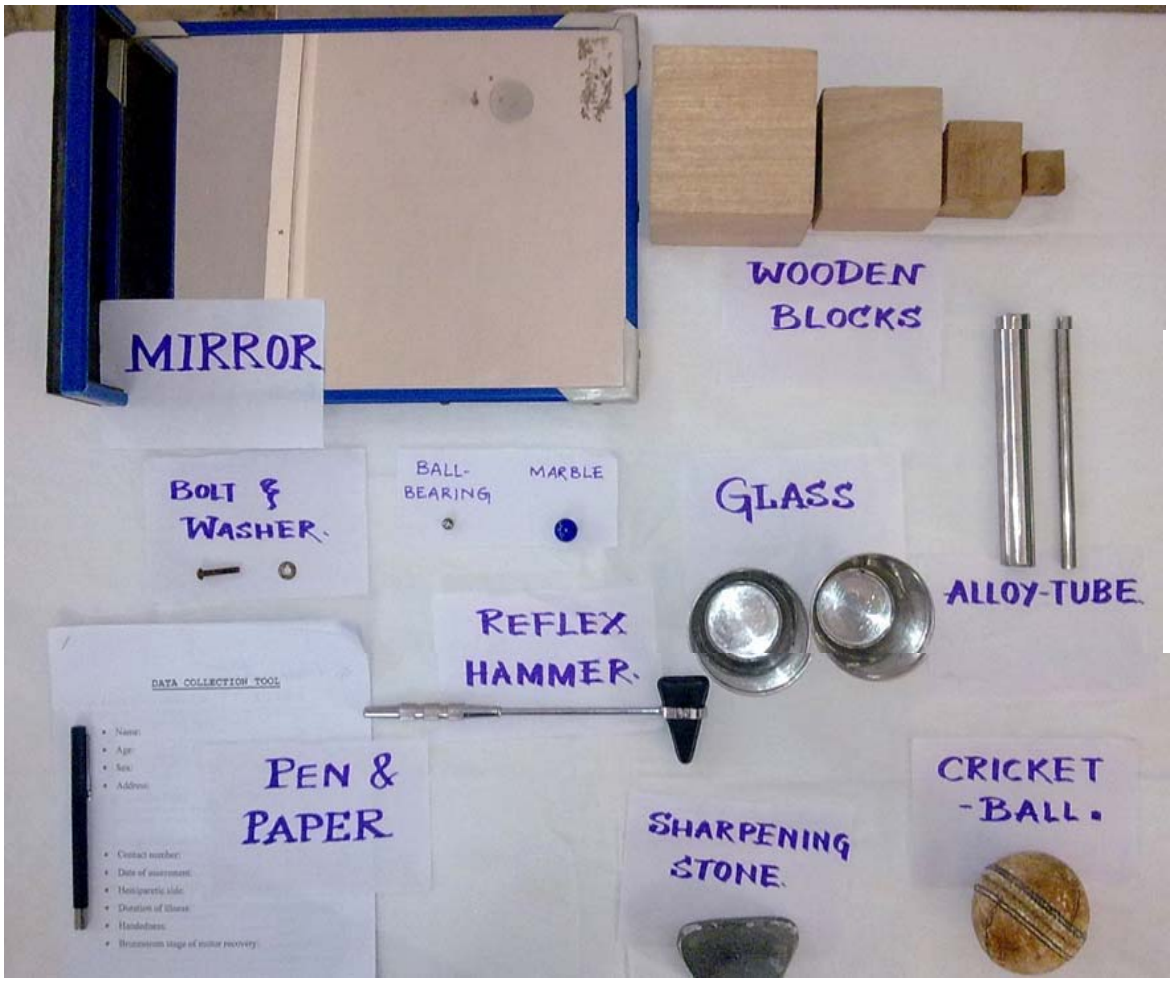


Figure 4.2: patient is doing wrist extension with reflected side of mirror towards normal side (group A)

Figure 4.3: patient is doing Supination-Pronation with reflected side of mirror towards normal side (group A)

Figure 4.4: patient is doing fingers Flexion-Extension with reflected side of mirror towards normal side (group A)

Figure 4.5: patient is moving an object with reflected side of mirror towards normal side (group A)

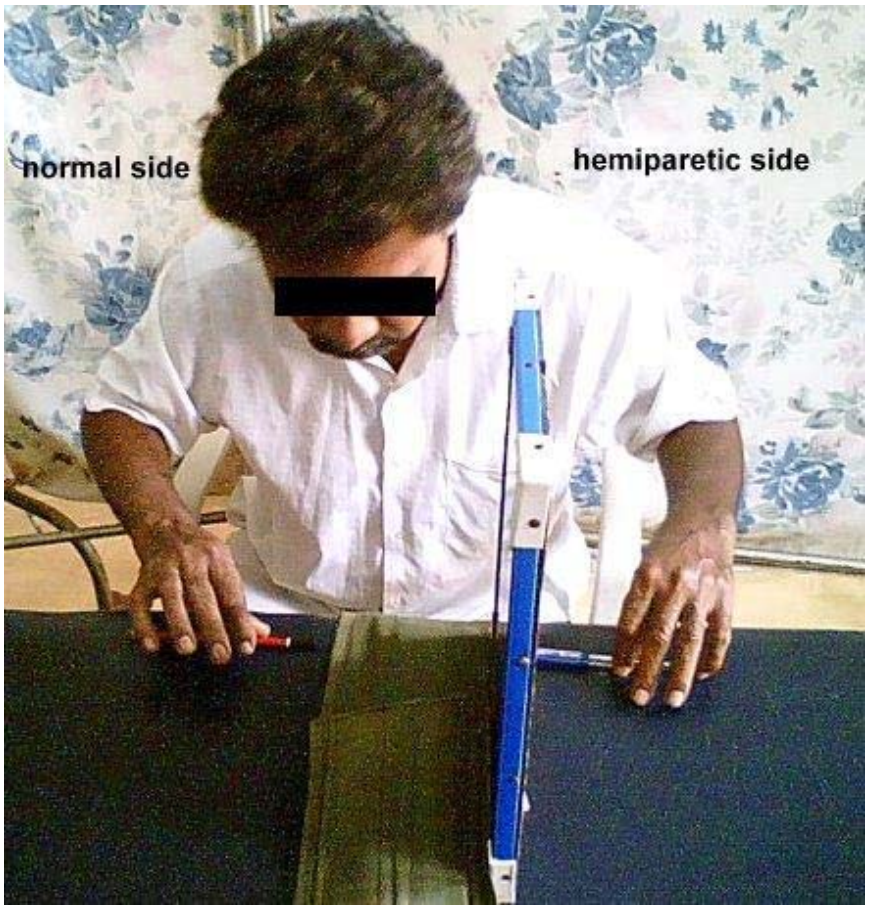
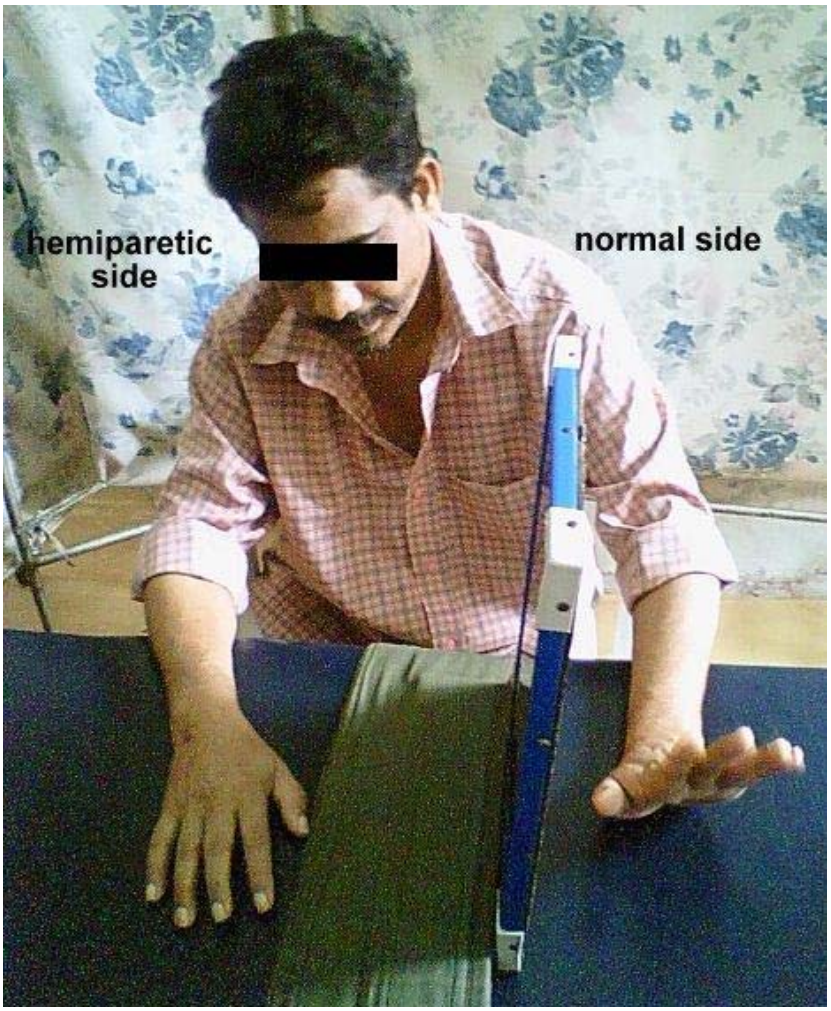


Figure 4.6: patient is doing wrist Extension with reflected side of mirror towards hemiparetic side (group B)



DATA ANALYSIS

1. ARITHMETIC MEAN

$$\overline{X} = \frac{\sum X}{N}$$

Where, $\overline{X}$ = Arithmetic

$\sum x$ = Sum of the variable

N = the total number of variables

2. STANDARD DEVIATION (S.D)

$$S.D = \sqrt{\frac{\sum (x - x)^2}{N}}$$

Where, x = the individual score

$\overline{X}$ = the mean score

N = the total number of scores

3. PAIRED t- TEST

$$t = \frac{\sum d}{\sqrt{\frac{N\sum d^2 - \left(\sum d\right)^2}{N-1}}}$$

Where, $\sum d$ = the total of the differences

$\left(\sum d\right)^2$ = the total of the differences, squared

$\sum d^2$ = the total of the squared differences

N = number of subjects, or pairs of matched subjects

$\sqrt{\ }$ = the square root of the final calculation of every thing under the square root sign

4. UNPAIRED t-TEST

$$t = \frac{\overline{X1} - \overline{X2}}{S_{\overline{X1} - \overline{X2}}}$$

Where, Numerator is the difference between the independent group means, or the effect Size, and denominator is the standard error of the difference between the means, representing the validity within the two samples.

$S_{\overline{X1} - \overline{X2}}$, using pooled variance is,

$$S_p^2 = \frac{S_1^2(n_1 - 1) + S_2^2(n_2 - 1)}{n_1 + n_{2-2}}$$

Where, S_1^2 and S_2^2 are group variances, and n_1 and n_2 are the respective of sample size.

Standard error of the difference between the means is given by:

$$S_{\overline{X1} - \overline{X2}} = \sqrt{\frac{S_p^2}{n_1} + \frac{S_p^2}{n_2}}$$

$$= \sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$$

RESULTS

Table 5.1: Descriptive statistics of Age of subjects in Mirror therapy and Control group

GROUP	N	Mean	Std. Deviation
Mirror therapy	11	53.00	4.517
control	11	54.64	7.420
Total	22	53.82	6.052

Table 5.1 shows the mean age of 11 subjects in Mirror therapy group is 53 ± 4.517 and the mean age of 11 subjects in control group is 54.64 ± 7.420. Mean age of total 22 subjects is 53.82 ± 6.053.

Table 5.2: Gender distribution in Mirror therapy and Control group

	Mirror therapy group		Control group		Total
	Count	**%**	**Count**	**%**	
male	5	45.5%	9	81.8%	14
female	6	54.5%	2	18.2%	8
Total	11	100.0%	11	100.0%	22

Table 5.2 shows that in Mirror therapy group, out of 11 patients, there are 5 (45.5%) male and 6 female (54.5%). In control group, there are 9 (81.8%) male and 2 (18.2%) female. Out of total 22 subjects, there are 14 male (64%) and 8 (36%) female.

Table 5.3: Intra group comparison of scores of ARAT between pre and post intervention in both groups

Group		Mean	Std. Deviation	Std. Error Mean	t	P
Mirror therapy	**Pre intervention**	18.1818	13.26513	3.99959	-7.906	.000
	Pre intervention	28.1818	14.75004	4.44730		
Control	**Pre intervention**	14.0000	10.89036	3.28357	-10.000	.000
	Post intervention	17.6364	11.48279	3.46219		

Table 5.3 shows that pre and post intervention mean ARAT scores in Mirror therapy group are 18.18±13.26 and 28.18±14.75 respectively; where as in control group are 14.00±10.89 and 17.63±11.48 respectively. There is highly significant difference between pre intervention and post intervention ARAT total scores in Mirror therapy group **(t= -7.96; p=0.000)** and in control group **(t= -10.00; p=0.000).**

Table 5.4: Intra group comparison of scores of FGMR between pre and post intervention in both groups

Group		Mean	Std. Deviation	Std. Error Mean	t	P
Mirror therapy	**Pre intervention**	29.272	12.5625	3.7877	-9.69	.000
	Pre intervention	41.545	9.9635	3.0041		
Control	**Pre intervention**	26.727	11.3056	3.4087	-7.63	.000
	Post intervention	32.727	9.7271	2.9328		

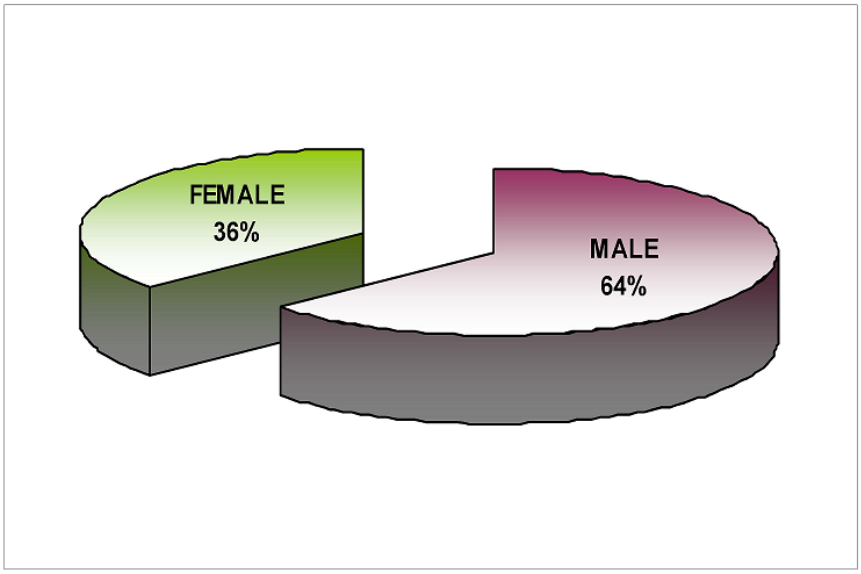
Table 5.4 shows that pre and post intervention mean FGMR scores in Mirror therapy group are 29.27±12.56 and 41.54±9.96 respectively; where as in control group are 26.72±11.30 and 32.72±9.72 respectively. There is highly significant difference between pre and post intervention FGMR total scores in Mirror therapy group **(t= -9.69; p=0.000)** and in Control group **(t= -7.63; p=0.000).**

Table 5.5: Inter group comparison of mean change scores (post - pre) of ARAT and FGMR between Mirror therapy and Control group

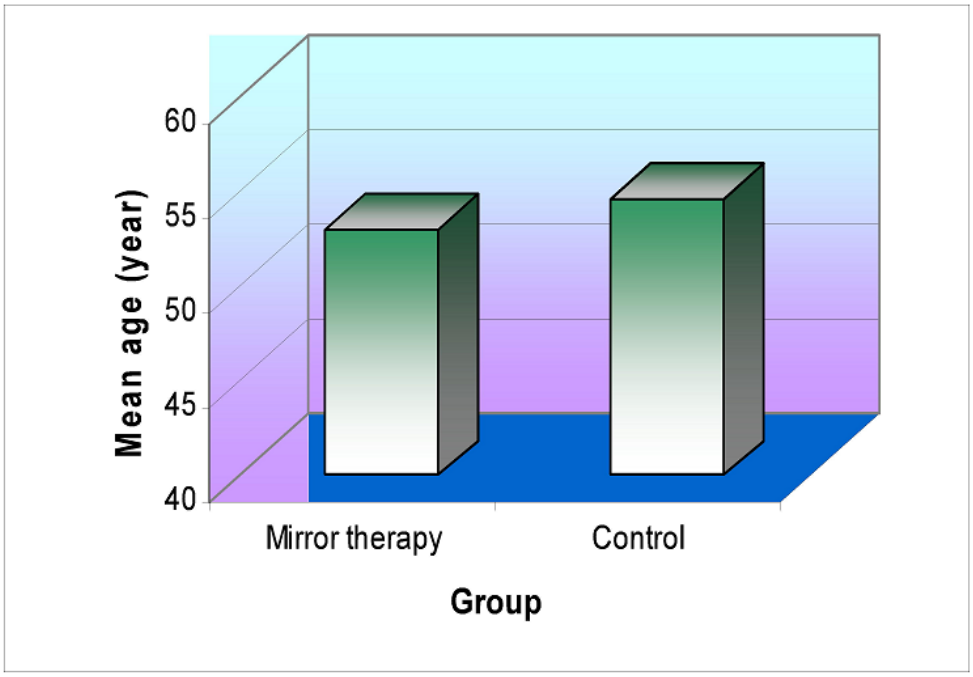
Scale	Group	Mean	Std. Deviation	Std. Error Mean	t	p
ARAT	Mirror therapy	10.000	4.1952	1.2649	4.83	.000
	Control	3.636	1.2060	.3636		
FGMR	Mirror therapy	12.272	4.1974	1.2655	4.21	.000
	Control	6.000	2.6076	.7862		

From table 5.5, it is understood that mean change score of ARAT (post - pre) in Mirror therapy group is 10.00±4.19 and in control group is 3.63±1.20. Mean change score of FGMR in Mirror therapy group is 12.27±4.19 and in control group is 6.00±2.60. There is highly significant difference of mean change scores (post - pre) of ARAT **(t=4.83; p=0.00)** and FGMR **(t=4.21; p=0.00)** between Mirror therapy group and control group.

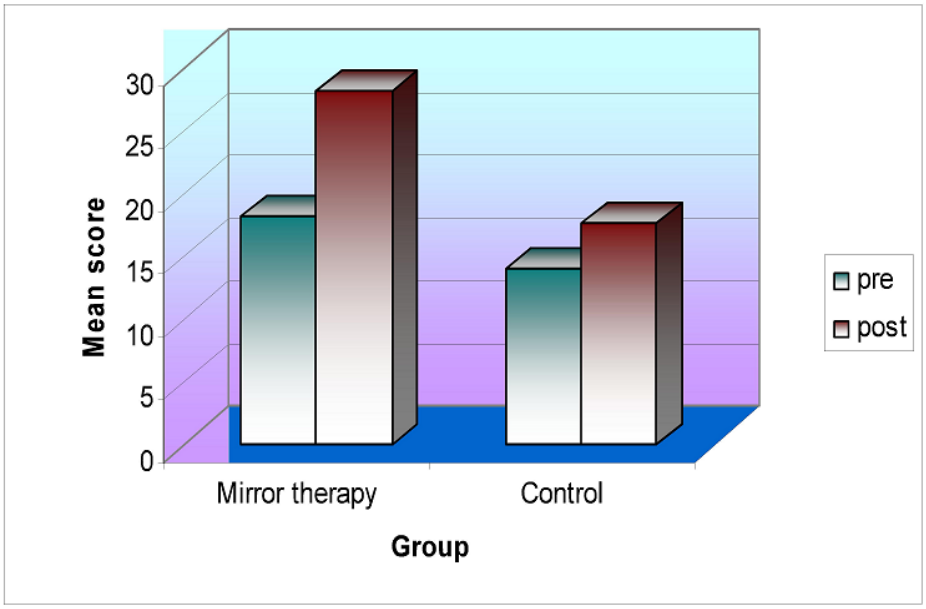
Graph 5.1: Gender distribution in Mirror therapy and Control group



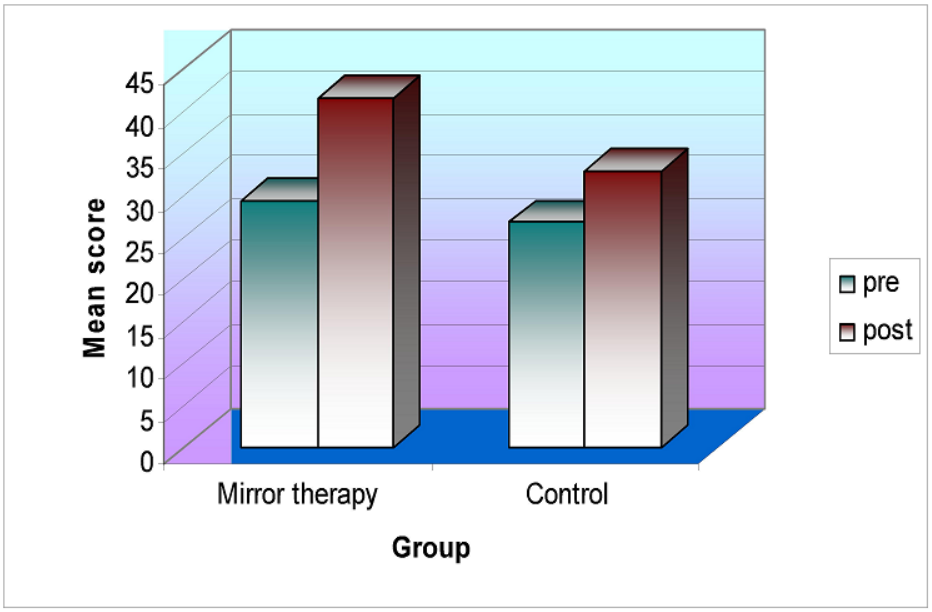
Graph 5.2: Age distribution in Mirror therapy and Control group



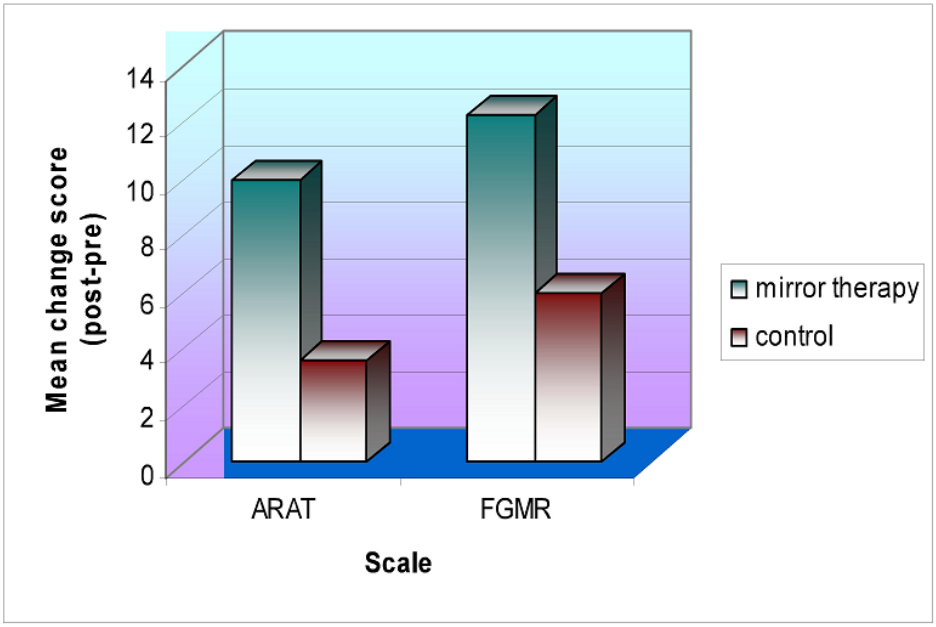
Graph 5.3: Shows changes in pre to post intervention mean scores of ARAT in Mirror therapy and Control group



Graph 5.4: Shows changes in pre to post intervention mean scores of FGMR in Mirror therapy and Control group



Graph 5.5: Shows changes in mean change score (post - pre) of ARAT and FGMR between Mirror therapy and Control group



DISCUSSION

Stroke is the leading cause of severe long term disability in adults. Six months after stroke, about 65 percent of patients cannot incorporate the affected hand into their usual activities and become a burden on family and society. Only 25 percent of patients return to the level of everyday participation and physical functioning of community-matched persons who have not had a stroke.

Traditional rehabilitation programs for improving functional use of the arm commonly used are compensatory strategies, splinting, task oriented practice strategies, constraint induced movement therapy, EMG biofeedback, acupuncture, strengthening exercises; and various approaches like NDT, PNF, Rood approach, Brunnstrom approach, Vojta approach.

Many studies have indicated that Mirror therapy may be a promising tool which can promote motor recovery, mobility, muscle strength, dexterity and functionality after stroke. Mirror therapy provides proper visual input that substitute for the often decreased or absent proprioceptive input. Mirror therapy is a motor imagery which may modulate central mechanisms of motor recovery and neural plasticity.

So, the objective of our study was to evaluate the effect of Mirror therapy on upper extremity motor functions and motor recovery in sub-acute stroke patients.

We have selected 22 patients with stroke who fulfilled inclusion and exclusion criteria. They were randomly divided into 2 groups: Mirror therapy group and control group. In Mirror therapy group, Mirror therapy and conventional therapy were provided, while in control group, same movements like Mirror therapy were given but mirror was placed in opposite direction. We have chosen 4 exercises: wrist dorsi flexion, fingers flexion-extension, supination-pronation and moving different objects. Motor functions were measured with ARAT and motor recovery with FGMR. Both the scales (ARAT and FGMR) are having good validity and reliability.

At the start of study the groups were uniform in their characteristics. Paired t- test was used to know the effects of Mirror therapy and placebo Mirror therapy along with conventional therapy in experimental and control group respectively. Results show that there was highly significant improvement in the score of ARAT in Mirror therapy group ($p=0.00$) and in control group ($p=0.00$). The results for FGMR

score were highly significant for Mirror therapy group (p=0.00) as well as in control group (p=0.00). So it is easily understood that interventions in both groups are effective.

We have also compared the Mirror therapy group and control group using unpaired t-test to investigate whether Mirror therapy group changed more compared to control group. Results show that mean change score of ARAT in Mirror therapy group was 10.00 and in control group was 3.63 where as, the change score of FGMR in Mirror therapy group was 12.27 and in control group is 6.00. There was highly significant difference in ARAT (p=0.00) and FGMR (p=0.00) scores between Mirror therapy group and control group after 4 week of intervention. This suggests that Mirror therapy is more effective than placebo treatment given in control group. This result is supported by **Gunes Yavuzer et al. Serap Sutbeyaz et al., Eric Lewin Altschuler et al., Stevens and Stoykov and K. Sathian et al.**

Gunes Yavuzer et al. did a study on 36 patients with subacute stroke which showed improvement in hand functions in the form of functional independence measure (FIM) score after Mirror therapy in addition to a conventional rehabilitation program compared with a control treatment directly after 4 weeks of treatment (p=0.01) and at the 6-month

follow-up (p=0.01), whereas Mirror therapy did not affect spasticity (p=0.904).

A study done by **Serap Sutbeyaz et al.** on 40 stroke patients have shown improvement in lower extremity motor recovery in form of Brunnstrom recovery stages (p=0.02) and lower extremity functions in form of FIM score (p=0.01) more in Mirror therapy group compared to control group after 4 week of intervention. Spasticity (p=0.102) and walking ability (0.610) did not improved more in Mirror therapy group.

Eric Lewin Altschuler et al. did a study on 9 patients with stroke and found that movement ability in terms of range of motion, speed, and accuracy was improved after 8 weeks of Mirror therapy.

Stevens and Stoykov did a case study using 2 patients with stroke and found that motor imagery for 4 weeks improves scores of Jebsen Test of Hand Function, the Fugl-Meyer Upper Extremity Motor Function Test, grip strength, range of motion and Chedoke-McMaster Stroke Assessment.

K. Sathian et al. did a case study on a post stroke patient with somato-sensory deficiency and found that Mirror therapy improves grip

strength, release time, shoulder range of motion, functional reach and upper extremity functions.

Many mechanisms, although not clearly understood, have been proposed for effect of Mirror therapy on functional improvement in stroke patients. **Altschuler et al.** reported that Mirror therapy provides proper visual input that substitute for the often decreased or absent proprioceptive input. Mirror therapy may also help to recruit the premotor cortex and also reverse elements of learned disuse. **Stevens and Stoykov** suggested that Mirror therapy is motor imagery which improves motor performance by priming the motor system at a central command level, which translates to a downstream effect of more controlled and faster movements. **K. Sathian et al.** suggested that Mirror therapy provides visual biofeedback which influences kinesthesis during active movement. It also facilitates use of more established strategies such as motor copy and forced use. **D. Goel and S. Goel** stated that Mirror therapy improves the functional outcome by facilitating plastic re-organization of the cortex in the brain in response to visual feedback.

We believe that Mirror therapy is motor imitation which implies motor observation, motor imagery and actual execution of movements. **Jeffery J. Summers et al.** suggested that a short-term bilateral training

intervention may be effective in facilitating upper limb motor function in chronic stroke patients. Mirror therapy incorporates movement of both extremities so it might be one of the mechanisms of Mirror therapy for motor recovery in stroke patients.

Buccino et al. have stated that motor imitation incorporates a widespread network with participation by a large number of brain regions such as supplementary motor area, superior and inferior parietal lobules, dorsal and ventral premotor cortices, prefrontal areas, inferior frontal gyrus, superior temporal gyrus, primary motor area, primary sensory cortex, secondary sensory area, insular cortex, anterior cingulate cortex, superior temporal gyrus, basal ganglia, and cerebellum. These networks integrate sensory inputs with stored motor patterns to generate the requisite movements.

Kimberley et al. observed ipsilateral activation of primary motor, primary sensory, supplementary motor and pre-supplementary motor areas during motor imagination in stroke patients.

In contrast, studies which contradict the neurophysiology for Mirror therapy were done by **Kozo Funase et al., M. I. Garry et al.** and **N. Sharma et al. Kozo Funase et al.** found that the somatosensory afferents that contributed to the kinesthetic sensations were not enhanced under mirror box observation and that mirror box therapy lacks the potential to increase M1 excitability in healthy subjects. However, the Mirror neuron system was activated during self-movement observation in both “mirror” and “no-mirror” conditions in a manner similar to that associated with observation of another person's movement.[32] **M. I. Garry et al.** found that mirror viewing enhances facilitation of ipsilateral primary motor area. By contrast, the difference between the Mirror and Active viewing conditions, in which subjects viewed the active hand directly, just failed to reach a conventional level of significance.[24] These studies lack the imagination and execution part of Mirror therapy as patients are asked only to observe the movement with or without mirror. **N. Sharma et al.** suggested that the underlying mechanism of motor imagery training-induced improved performance suggested by literatures remains unclear.

So it can be inferred that, although neurophysiology of Mirror therapy for motor recovery is not clear, it can be an adjunct to

rehabilitation program which can be applied early in stroke rehabilitation for some patients.

LIMITATIONS OF THE STUDY

- Sample size was small.
- The study was conducted for short duration i.e. 4 weeks.
- The area of brain involved and type of stroke i.e. ischemic / hemorrhagic were not specified.

RECCOMENDATIONS FOR FURTHER STUDY

- Studies to know the underlying mechanisms of motor recovery after Mirror therapy in stroke patients can be done.
- More randomized controlled trials of Mirror therapy in stroke rehabilitation are required to make protocol of Mirror therapy in stroke patients.
- Studies to compare motor imagery with and without mirror for stroke rehabilitation are required.

CONCLUSION

This study concludes that:

- Mirror therapy improves upper extremity motor functions in stroke patients.

SUMMARY

Stroke is the common condition which leads to disability in many patients who survives after attack. The rehabilitation of stroke patients is mainly directed towards functional improvement. Mirror therapy is a relatively new approach which may improve motor functions in stroke patients. It provides visual feedback, increases cortical excitability and modulates neural plasticity in stroke patients.

We have selected 22 patients with one attack of stroke, duration of illness between 2 to 12 months and brunnstrom stage of motor recovery between 1 to 3 with no cognitive impairment (MMSE>23). Patients were randomly divided into 2 groups: Group A and Group B. Patients in group A were treated with Mirror therapy and conventional therapy; where as in group B, patients were treated with placebo Mirror therapy and conventional therapy. ARAT and FGMR were used to assess motor functions before and after intervention.

Then data was tabulated and analyzed statistically. Paired and unpaired t-tests were used to evaluate effect of interventions in both groups and the effect of mirror therapy on upper extremity motor functions compared to control group respectively.

The analysis leads to inference that mirror therapy along with conventional therapy showed batter result when compared to intervention in control group.

Mirror therapy was found to be effective in improving upper extremity motor functions in stroke patients.

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